

Comparative Test of  
Aircrew Pressure Suits

Conducted by  
4750<sup>th</sup> Test Sqdrn  
Tyndall AFB, Fla  
Report dated 1 Apr 61

### COLD WATER SURVIVAL TEST

**ENVIRONMENT** - On 13 December 1960, the Cold Water Survival Test was conducted in Lake Superior at Duluth, Minnesota. The weather conditions were: High thin overcast, temperature ranged from 10° to 21° F, wind speed varied from 10 to 18 knots, and the water temperature was 33° F.

**ATTIRE** - Four pilots from the 325th FIS each wore one of the four types of pressure suits being evaluated; the S-2, S-3, 4/P and 5/P. The pilot in the CSU-4/P Partial Pressure Suit also wore the insulated coverall (CWU-4/P), which is the anti-exposure garment designed to be used with that suit. In addition to the respective headpieces and suit gloves, each test subject had on the following:

- One set of Waffle Weave Long Underwear.
- One set of Cotton Trilock, worn over the Waffle Weave.
- One pair of Thermal Socks.
- One pair of Wool Socks worn over Thermal.
- One pair of Rubber Thermal Boots, 10" w/zipper.
- One pair of Exposure Mittens worn over pressure suit gloves.

**TEST CONDITIONS** - Each subject jumped from about a ten foot height into the lake. All four testers wore an inflated LPU-2/P Underarm Life Preserver. Each man remained in the water for 15 minutes, then boarded a one-man life raft. Throughout this test a flight surgeon observed the test subjects and he took oral temperatures periodically. (See Attachment 1, Flight Surgeon's Report.) It should be pointed out that these temperature readings did not give an indication of true body temperature, but were taken to determine a trend only.

TEST RESULTS - A/P-22S-2 - The test subject in this garment remained in the water for 15 minutes, then boarded the life raft without difficulty. He remained in the raft for an hour and 15 minutes, then got back into the water for 15 minutes before terminating the test.

OBSERVATIONS - This pilot displayed no outward symptoms of exposure either during or after the test. He did state that he was cold, especially in the lower extremities of the body, but it was not an extreme cold. After leaving the water, the subject could walk with ease and his overall condition and general demeanor appeared normal. A small amount of water had leaked into the suit (approximately one-half pint); however, this was normal and within suit specifications. Total time spent in water and life raft was 1:45.

A/P-22S-3 - This subject remained in the water for 15 minutes prior to boarding a one-man life raft. He remained in the raft for 1:15 during which time he did not suffer undue discomfort. Subject experienced coldness similar to that voiced by the tester in the S-2 garment. Prior to terminating the test, this pilot returned to the water for 15 minutes.

OBSERVATIONS - As in the case of the tester in the S-2 garment, this subject fared quite well. He displayed no symptoms of serious exposure such as discoloring, numbness, or excessive chills. Subject was able to move about unassisted and he expressed the opinion that he could have remained in the life raft for a considerable period of time. Total time in water and life raft was 1:45.

CSU-4/P - The pilot testing this pressure suit first entered the water and remained there for 15 minutes, as did the other test subjects. After only one minute in the water, this subject became extremely cold. He had considerable difficulty boarding the life raft because his legs were numb with cold. Although he suffered extreme cold while sitting in the life raft, the subject stated that he tolerated the cold better by remaining as immobile as possible. After approximately 15 minutes in the raft, the subject looked extremely cold and was shivering noticeably, yet he stated that he was not really cold! Less than ten minutes later, this man began to shiver violently (shaking chills) and the flight surgeon then ordered him to cease the test. Because of the numbness in his legs, the subject had to be helped from the dinghy and assisted to the dressing area.

**OBSERVATIONS** - This tester suffered the most from the cold exposure. Just prior to leaving the raft, his oral temperature had dropped to 94+° F. His skin was mottled cyanotic in color; pulse rate was rapid; body movement was slow, labored, semi-stuporous, and he had the shaking chills. In spite of the long exposure to cold, this pilot did not complain of pain and he encountered no after-effects from his ordeal. Total time spent in water and life raft was 40 minutes.

**CSU-5/P** - Similar to the previous tester, this subject became quite cold after only a minute or two in the water. He had no significant trouble in boarding the life raft, however. This tester also became extremely cold within ten minutes after boarding the life raft. Flight surgeon recommended that he discontinue the test and about ten minutes later subject came ashore. Just prior to this, his oral temperature reading was 95+° F.

**OBSERVATIONS** - This pilot, although extremely cold and shaking from the exposure, was in relatively good condition compared to the tester in the CSU-4/P suit. He showed no outward symptoms of advanced exposure and was able to move about unassisted. Subject later stated that he believed he could have possibly endured the test a little longer; perhaps 20 or 30 minutes more. Total time spent in water and life raft was 39 minutes.

**SUMMARY** - Results of this test indicate that the maximum time an individual can withstand exposure, under the conditions set forth in this test, is:

a. With the CSU-4/P, 5/P garments - approximately one hour. (The coverall worn over the 4/P suit afforded no extra protection against the cold water.)

b. With the A/P-22S-2, S-3 garments - five to six hours, probably longer.

If the subject should be exposed to a lower ambient and/or water temperature, then the above times would certainly be reduced.

## FLIGHT SURGEON'S REPORT - COLD WATER TEST

### 1. Procedure

a. Prior to exposure, pilots involved in the test were given a brief examination to determine whether or not any illness or physical abnormality had developed recently which might interfere with the test.

b. Base-line vital signs were obtained before the subjects donned their respective suits.

c. During the actual testing phase vital signs (oral temperature and pulse-rate) were obtained at appropriate intervals.

d. At the termination of the cold exposure a cursory examination was again performed and a complete set of vital signs obtained.

### 2. Results

a. No physical abnormalities or evidence of recently acquired acute illness were found on the initial examination of the subjects.

b. Vital signs obtained throughout the test are listed in Tab 1.

c. Pertinent physical findings at termination of test:

(1) Subject R. G. - Slight pallor of skin, shaking  
(5/P) chills, sensorium, motor functions  
and mental acuity all within normal  
limits.

(2) Subject R. K. - No demonstrable abnormalities.  
(S-2)

(3) Subject B. N. - Moderate skin pallor with areas of mottled cyanosis on the upper trunk, face and arms. Severe shaking chills starting 10 to 15 minutes after removal from the cold environment. During the first 10 or 15 minutes after the subject left the water there was evidence of definite muscular weakness, decreased sensation and semi-stupor. At first the subject had difficulty moving his lower limbs and responded rather slowly and feebly to questioning. Recovery was virtually complete in approximately 30 minutes.

(4) Subject J. M. - No demonstrable abnormalities.  
(S-3)

### 3. Comments

a. Little if any significance can be attached to the above recorded vital signs other than possibly an indication of a trend in body heat loss or perhaps an idea of peripheral vascular tone at the completion of the test. In two cases (R. G. and B. N.) the available evidence seems to point toward an early and progressive loss of large amounts of body heat throughout the test. The early signs of peripheral vascular collapse in addition to the central nervous system changes usually seen in cases of extreme cold exposure were manifested in one case. (B. N.)

b. The 4/P and 5/P Partial Pressure Suits offer little, if any, barrier to the out-flow of body heat in the cold environment. The maximum survival time under the test conditions would probably be about one and one-half to two hours. At the one hour point exercise ability fell off markedly and this was known to be a critical factor.

c. The S-2 and S-3 Full Pressure Suits are very effective in insulating the body under conditions similar to those seen in the test. The nature of this particular test does not permit an appraisal of maximum survival time with these two suits. The subjects were certainly not pushed to anywhere near their limits of endurance or discomfort. Unquestionably with a moderate amount of exercise the maximum survival time would be many hours.

Subject	INITIAL			5 Minutes			15 Minutes			30 Minutes			1 Hour			FINAL		
	Suit Temp	Blood Pressure	Pulse Rate	Temp	Pulse	Temp	Pulse	Temp	Pulse	Temp	Pulse	Temp	Pulse	Temp	Pulse	Temp	Pulse	Blood Pressure
K.	S-2	98.6	120/80	80	20	98	88	97.6	100	97.6	100	97	100	97.2	100	118/80		
M.	S-3	98.6	120/80	78	18	97.8	90	97.8	108	97	100	97.8	100	97	100	124/84		
N.	4/P	98.6	120/80	80	20	97	90	96	100	95	100	94.8	100	94	100	100/68		
G.	5/P	98.6	120/80	86	20	98	88	97.6	100	96	100	95	110	94.6	120	92/64		

NOTE: All temperatures shown are oral and are in degrees Fahrenheit.

ATTACHMENT # 3

16 April 1969

Approved For Release 2002/08/01 : CIA-RDP75B00285R000100050006-0

~~This investigation is being conducted by our High Reliability Soldering Section. Techniques and procedures are being re-evaluated to assure that optimum reliability is being obtained.~~

#### 5. Recommendations

[redacted] visited GN the week of 17 March.

STATINTL

Pockets were designed and installed on the S/N 400 prototype exterior cover. These were to contain assorted survival equipment originally packed in the seat kit.

On 18 March cold water exposure tests were conducted using the prototype PPA. The test definitely indicated that additional thermal protection is needed.

We would like to design and fabricate an anti-exposure layer for the S1010 PPA. It will be an orally inflatable envelope that can be installed between the liner and the gas container layer of the coverall. It will attach to the liner with snaps so that it can be easily installed and removed. This unit would be utilized only when a specific mission could subject the pilot to cold water exposure.

The anti-exposure layer would be fabricated from a thin, lightweight polyurethane-coated nylon material. It would be the same size as the coverall liner, and will cover the subject from the glove disconnects up to the helmet disconnect and down to the lower calf.

Our preliminary intent is that it would be orally inflated after the subject is in his raft, by a tube that is located either at the wrist disconnect or helmet disconnect. The disconnect would be opened, the inflation hose pulled out, and the subject would orally inflate the unit from 2 to 5 millimeters of mercury. This would form a thermal protective layer of air approximately 1/2 inch thick between the subject and the outer layers of the coverall. (See Figure #1).

A pair of mittens would also be provided. They would fit over the full pressure gloves and provide drastically needed protection.

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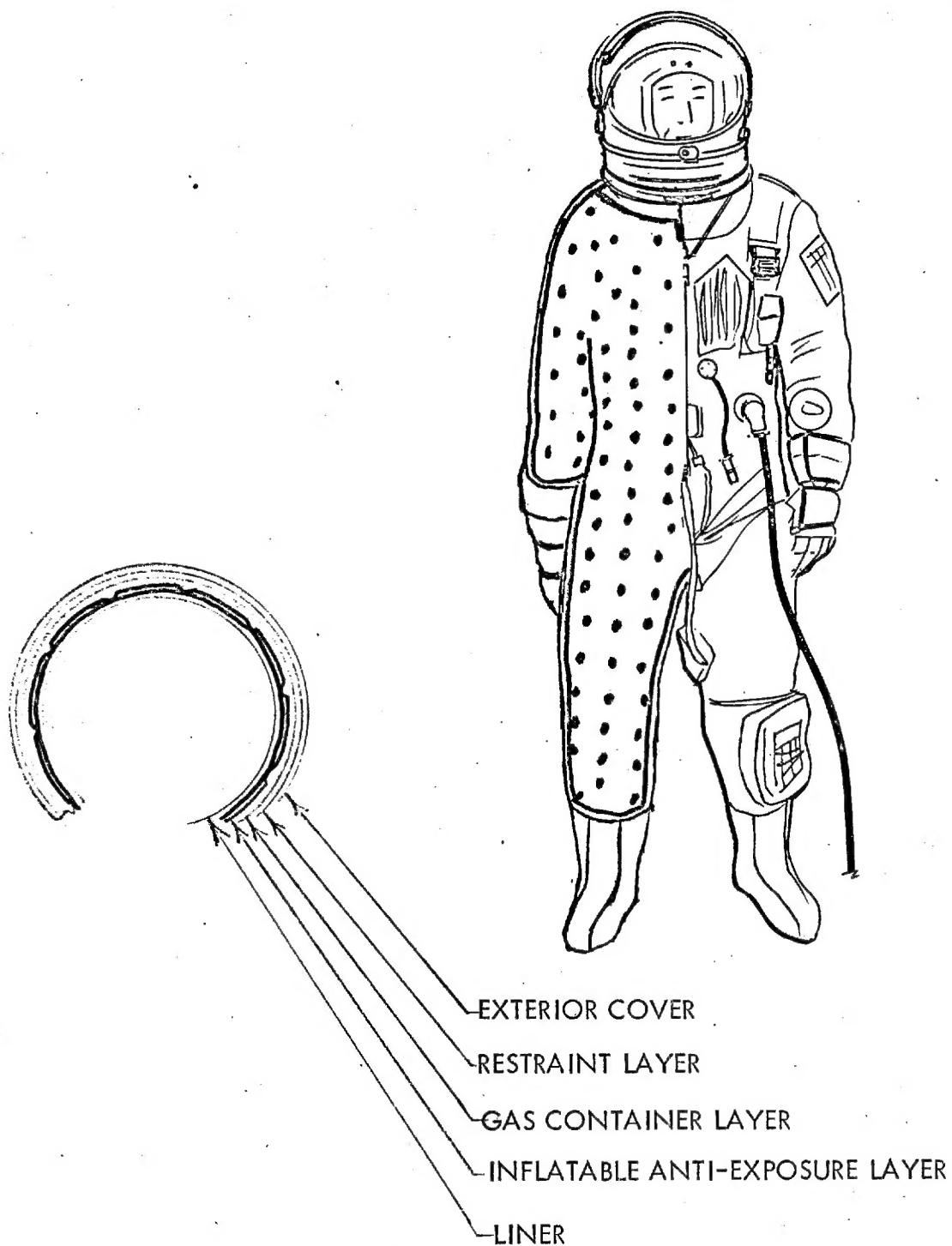


Figure #1